Overview of CSO Modeling Study Results –

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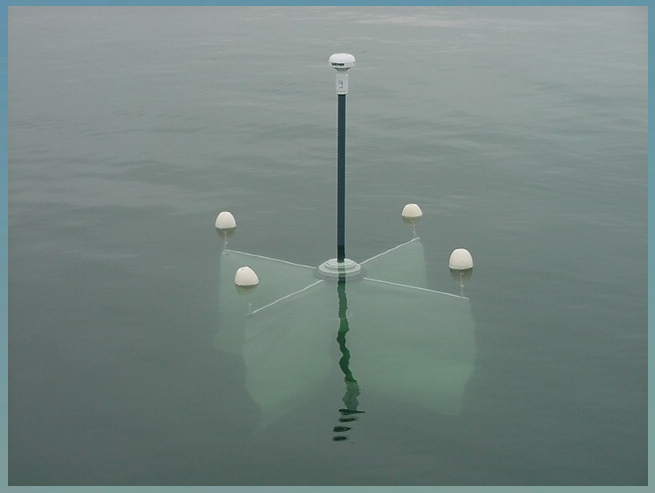
PSNS & IMF Project ENVVEST TWG Meeting
July 23, 2003
Bremerton, WA

- Background of CSO Modeling Study
- Calculation of Threshold Flow Rate and Storm Water Overflow Volumes
- Animations of Representative CSO Events
- Discussion
- Schedule

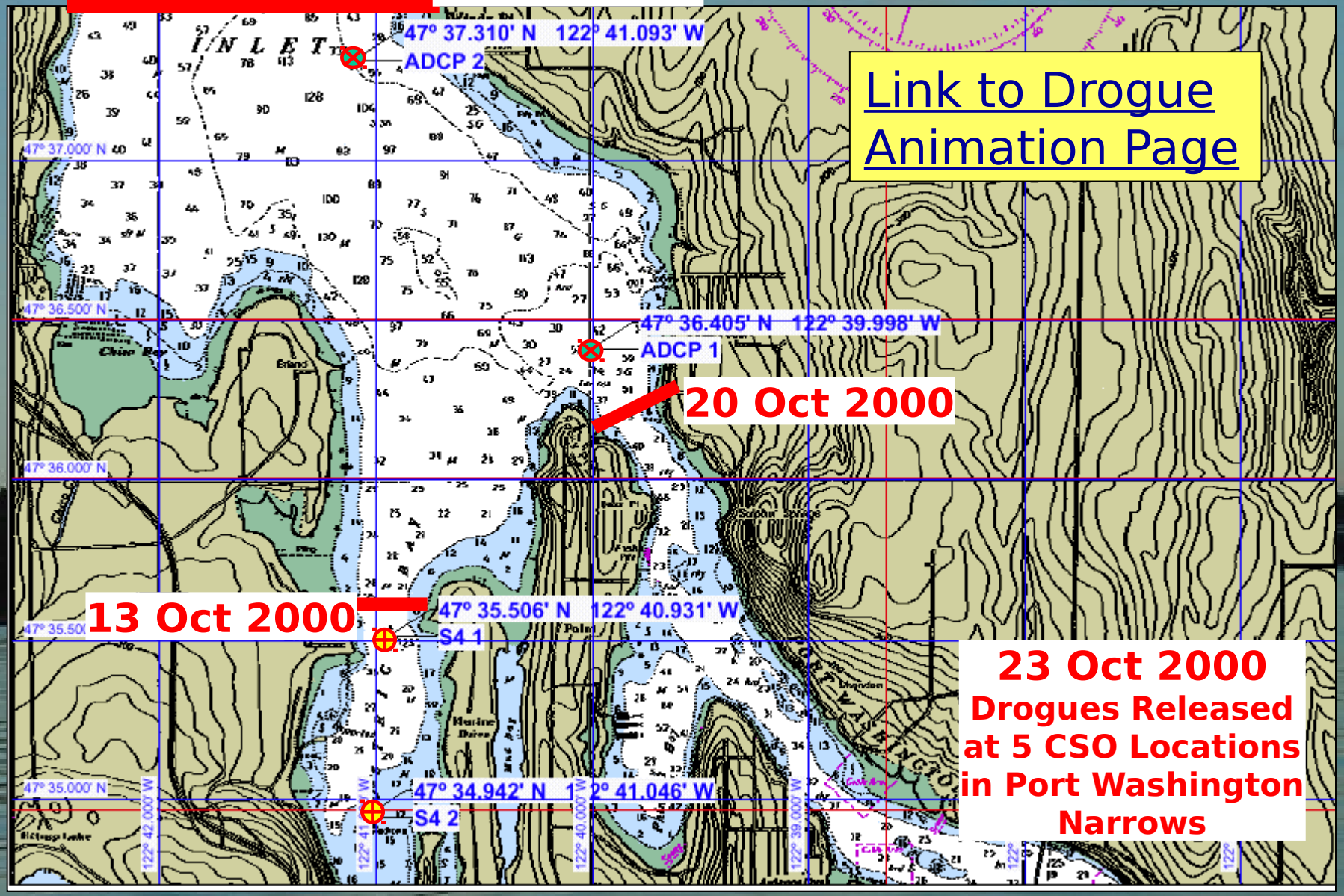
Impetus for Study

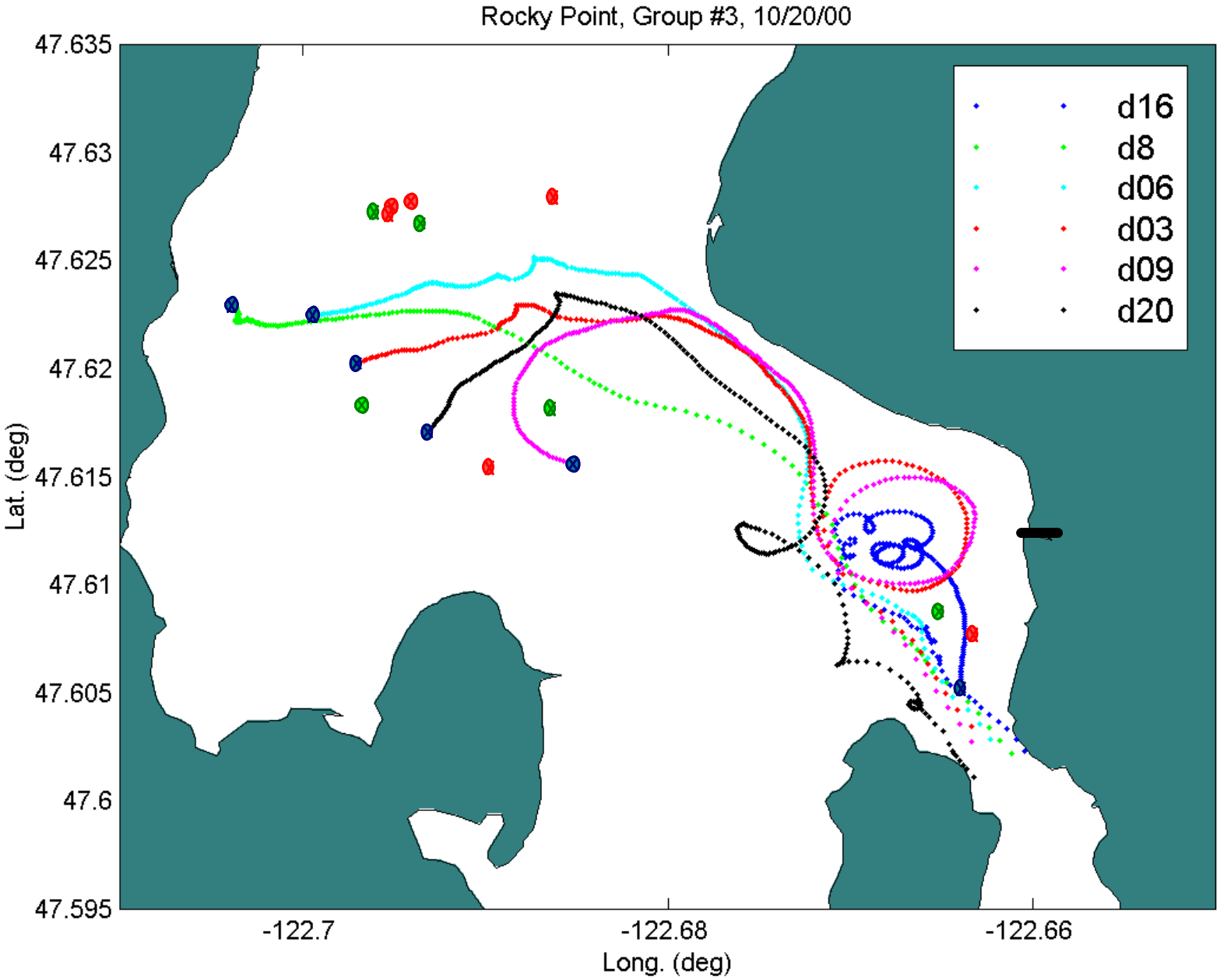
- **Stakeholder Sub-Working Group**
  - Suquamish Tribe, Dept. of Health, City of Bremerton, Kitsap County, CTC, US Navy
- **Problem**
  - Shellfish beds in Upper Dyes Inlet remain closed due in part to uncertainty about CSO overflows in the Port Washington Narrows
- **Cooperative CSO Study Developed**
  - Calibrate/Validate Model to simulate “typical” CSO overflow event on incoming tide
  - Drogue & Current Meter Study – Fall 2000
  - Dye Study – March 2002

Drogue and Current Meter Study



Drogue Study Plan



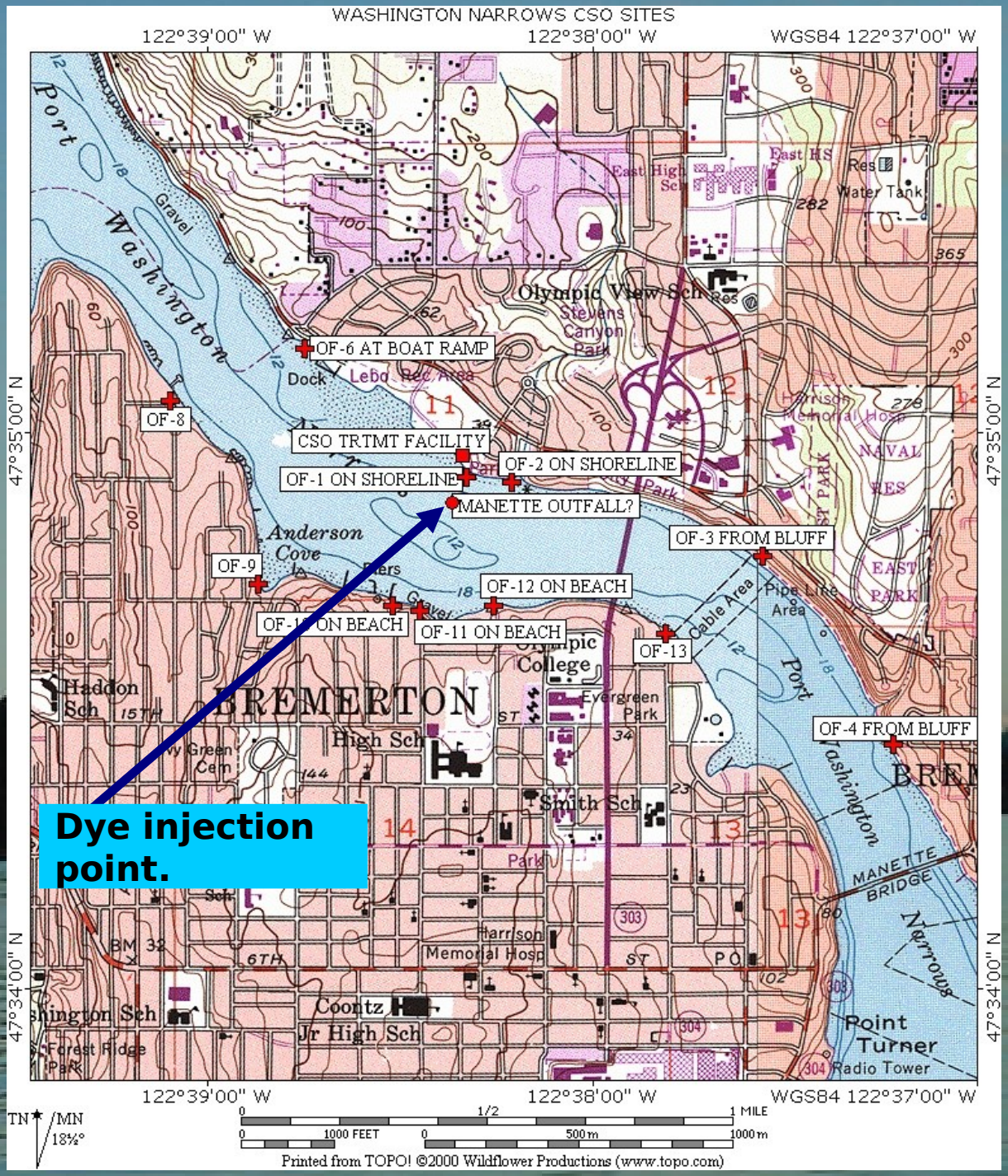

Rocky Point, Group #3, 10/20/00
47.635
47.63
47.625
47.62
47.615
47.61
47.605
47.6
47.595
Lat. (deg)
-122.7
-122.68
-122.66
Long. (deg)
d16
d8
d06
d03
d09
d20

Dye Release Study

Objectives

- Simulate a CSO discharge event in the Port Washington Narrows on the incoming tide.
- Provide physical and chemical data sets for validating model performance.
- Develop data on ambient concentrations of fecal coliform and selected contaminants in the estuary.

Dye Release


WASHINGTON NARROWS CSO SITES
122°39'00" W
122°38'00" W
WGS84 122°37'00" W
47°35'00" N
47°34'00" N
OF-6 AT BOAT RAMP
OF-8
CSO TRTMT FACILITY
OF-1 ON SHORELINE
OF-2 ON SHORELINE
MANETTE OUTFALL?
OF-3 FROM BLUFF
OF-9
OF-12 ON BEACH
OF-11 ON BEACH
OF-13
OF-4 FROM BLUFF
Dye injection point.
BREMERTON
Olympic View Sch
Anderson Cove
Port Washington
Narrows
MANETTE BRIDGE
Point Turner
Radio Tower
Harrison Memorial Hosp
Coontz Jr High Sch
Smith Sch
Haddon Sch
Forest Ridge Park
Evergreen Park
Stevens Canyon Park
Pipe Line Area
Cable Area
East HS
Water Tank
NAVAL RES
EAST PARK
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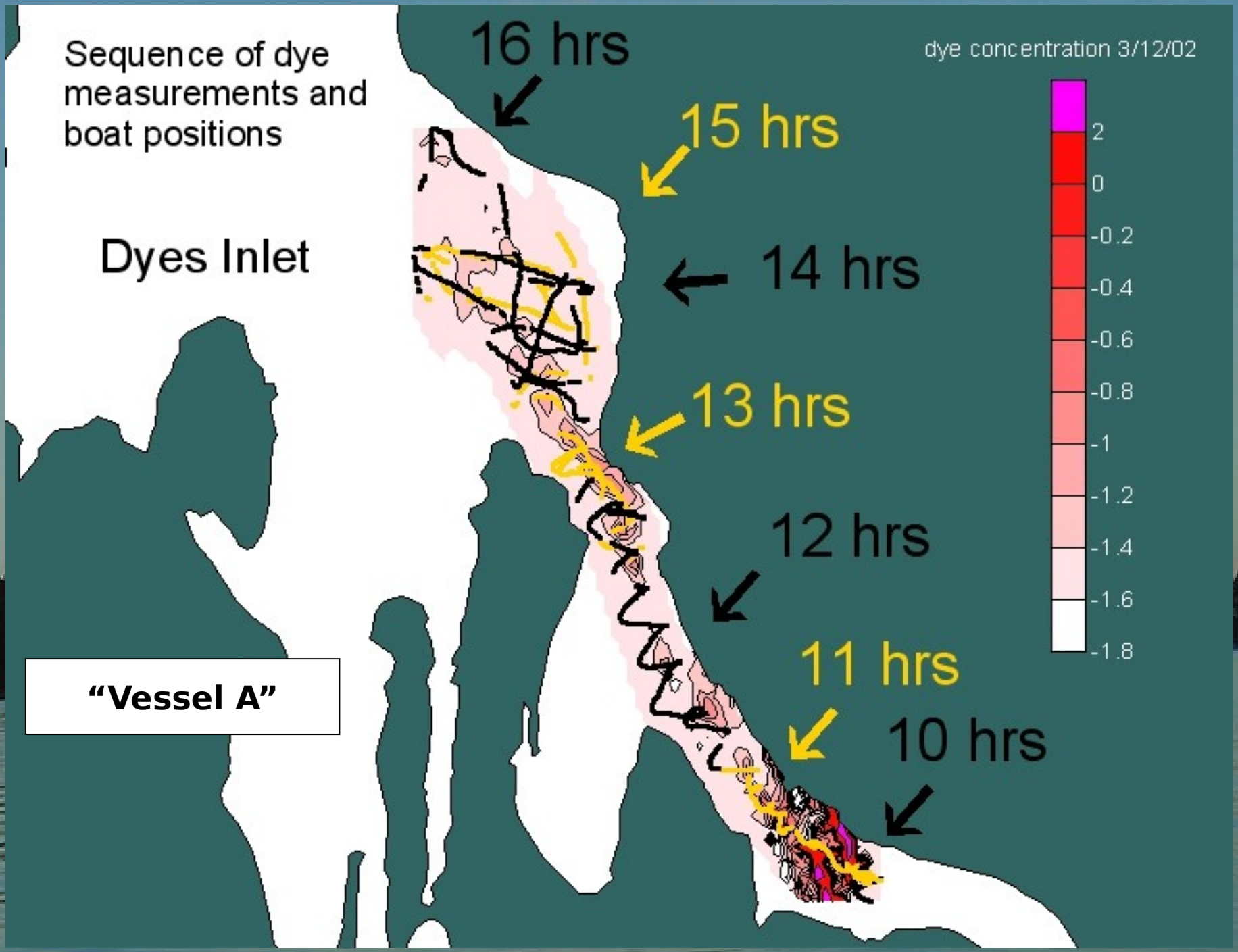
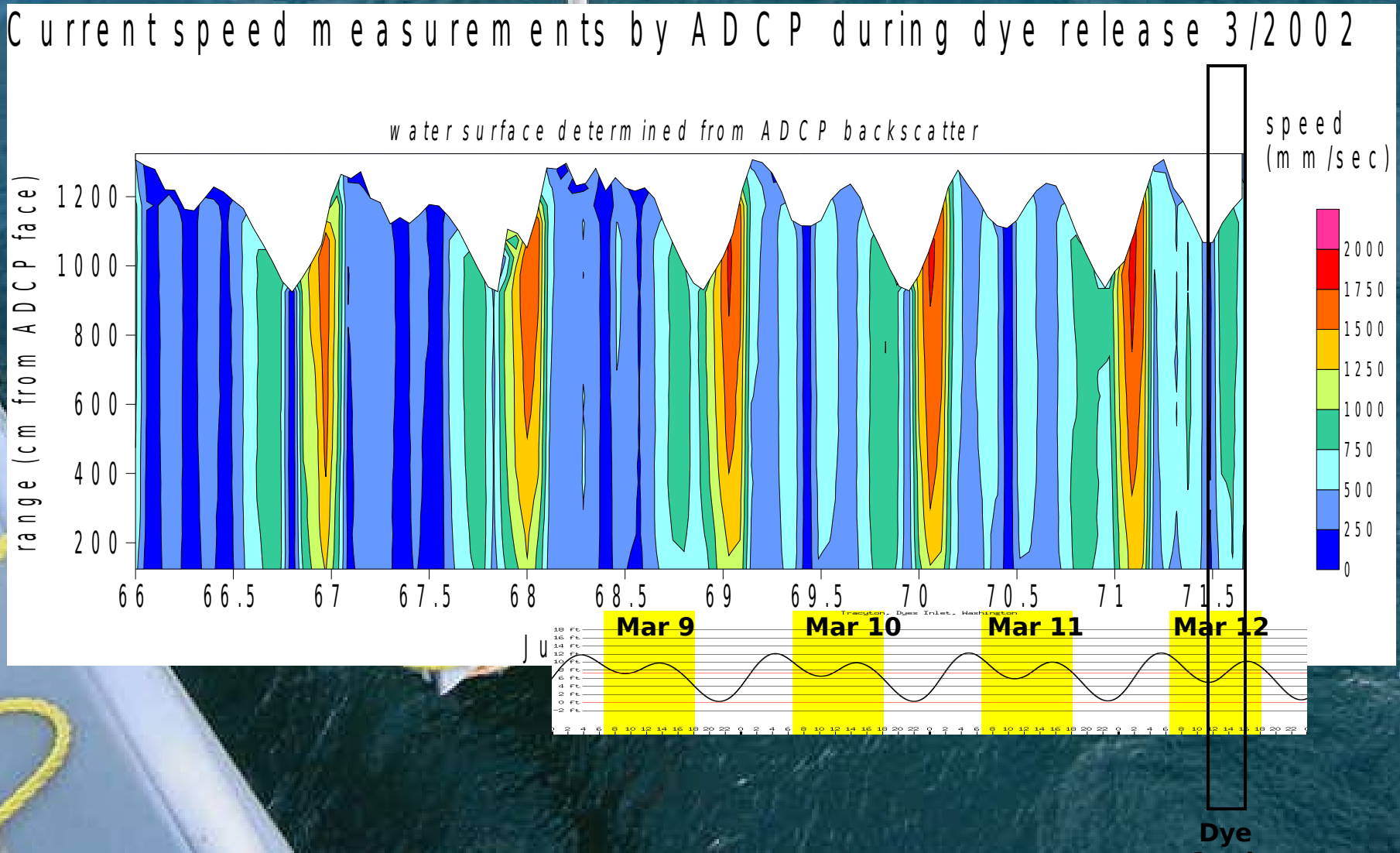
Dye Release Study


Sequence of dye measurements and boat positions
Dyes Inlet
16 hrs
15 hrs
14 hrs
13 hrs
12 hrs
11 hrs
10 hrs
dye concentration 3/12/02
2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
“Vessel A”

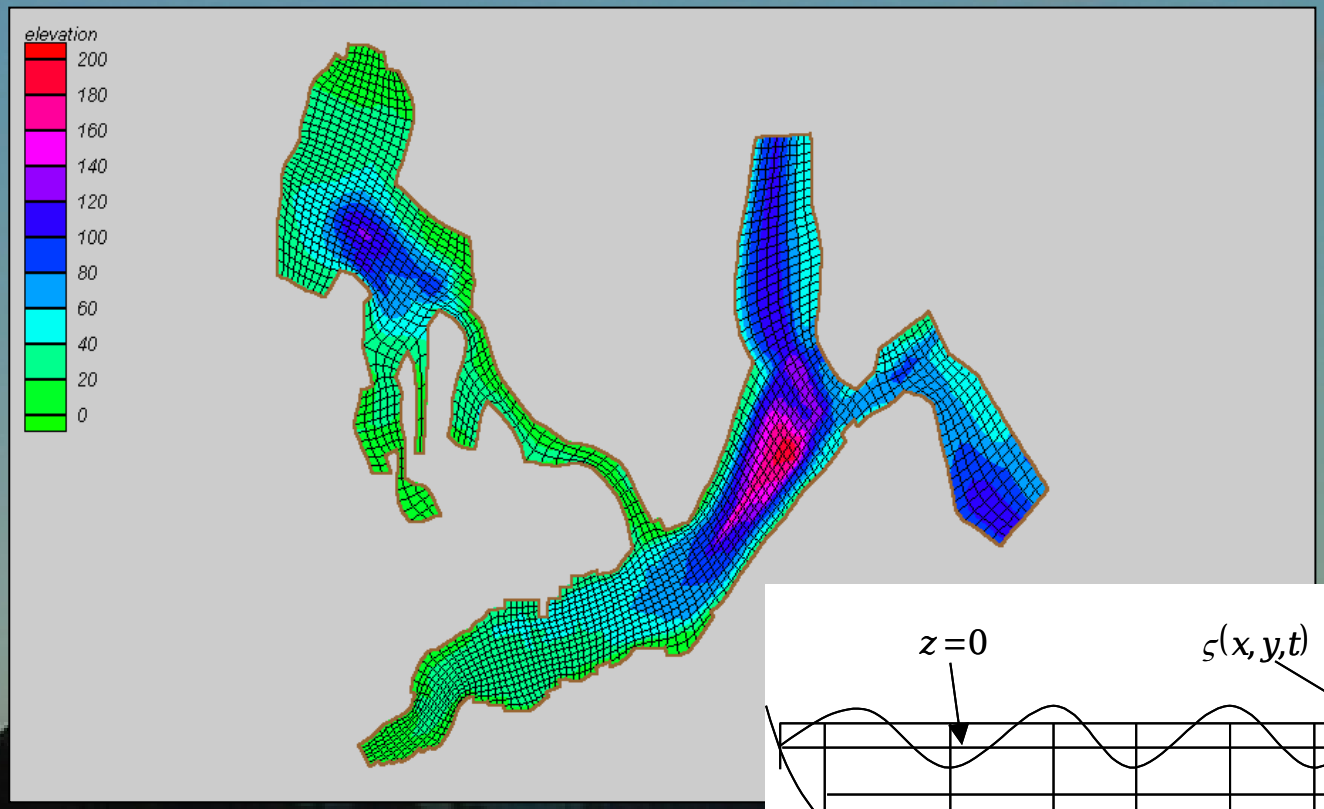
Current Profile

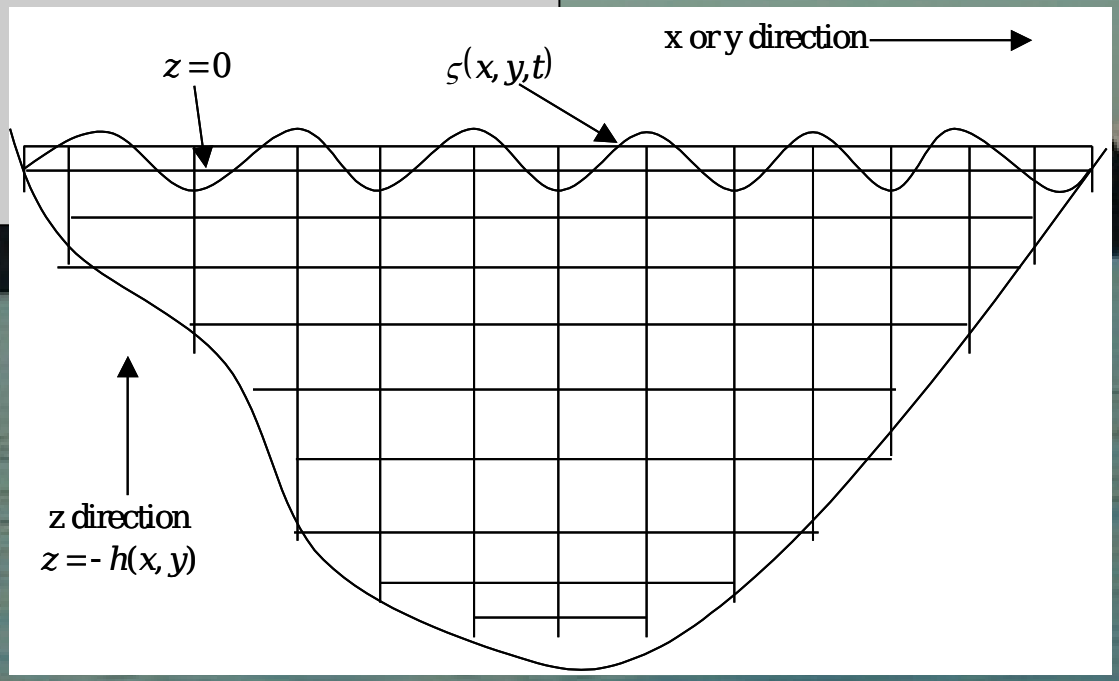


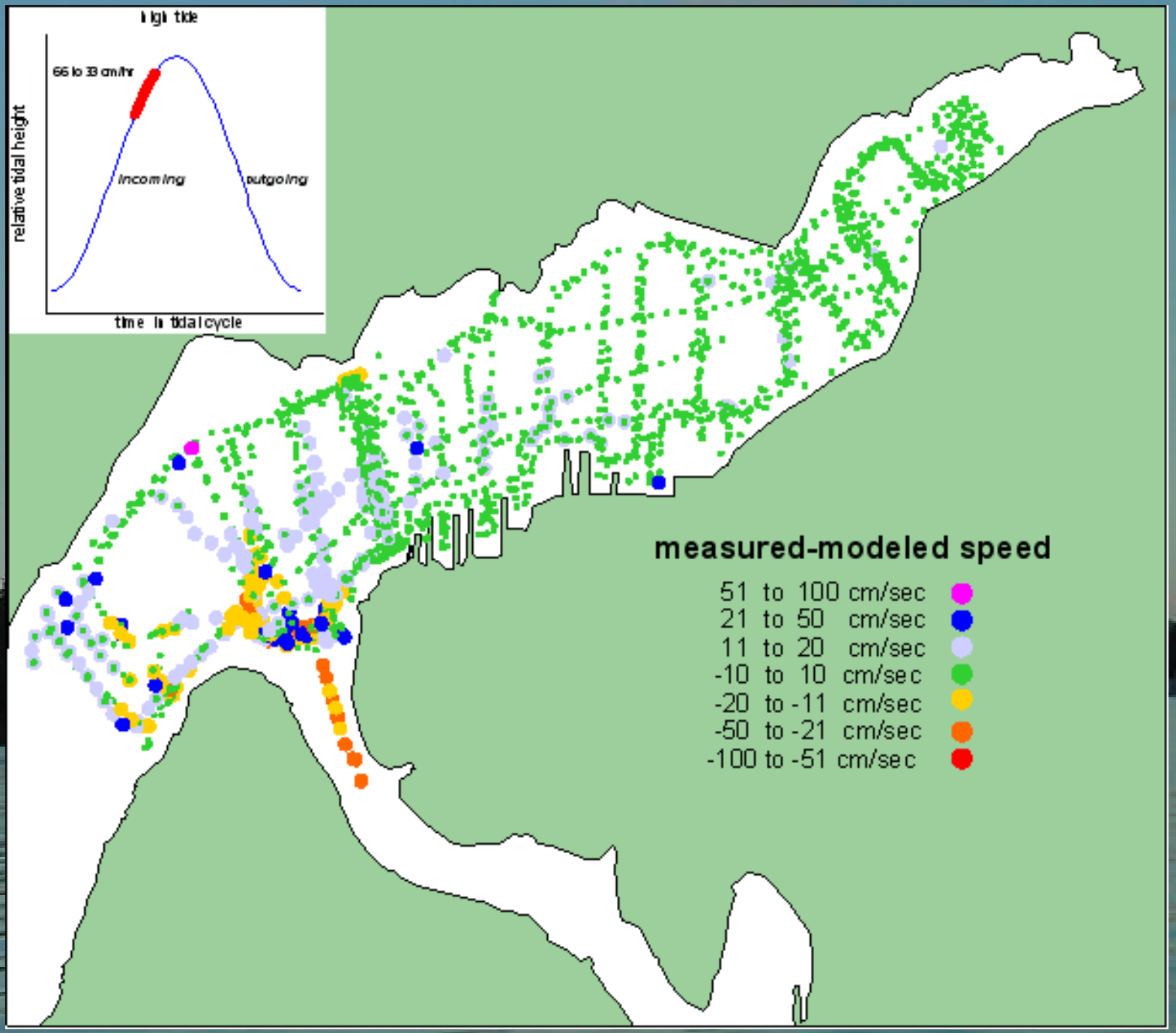
CH3D-FC Model

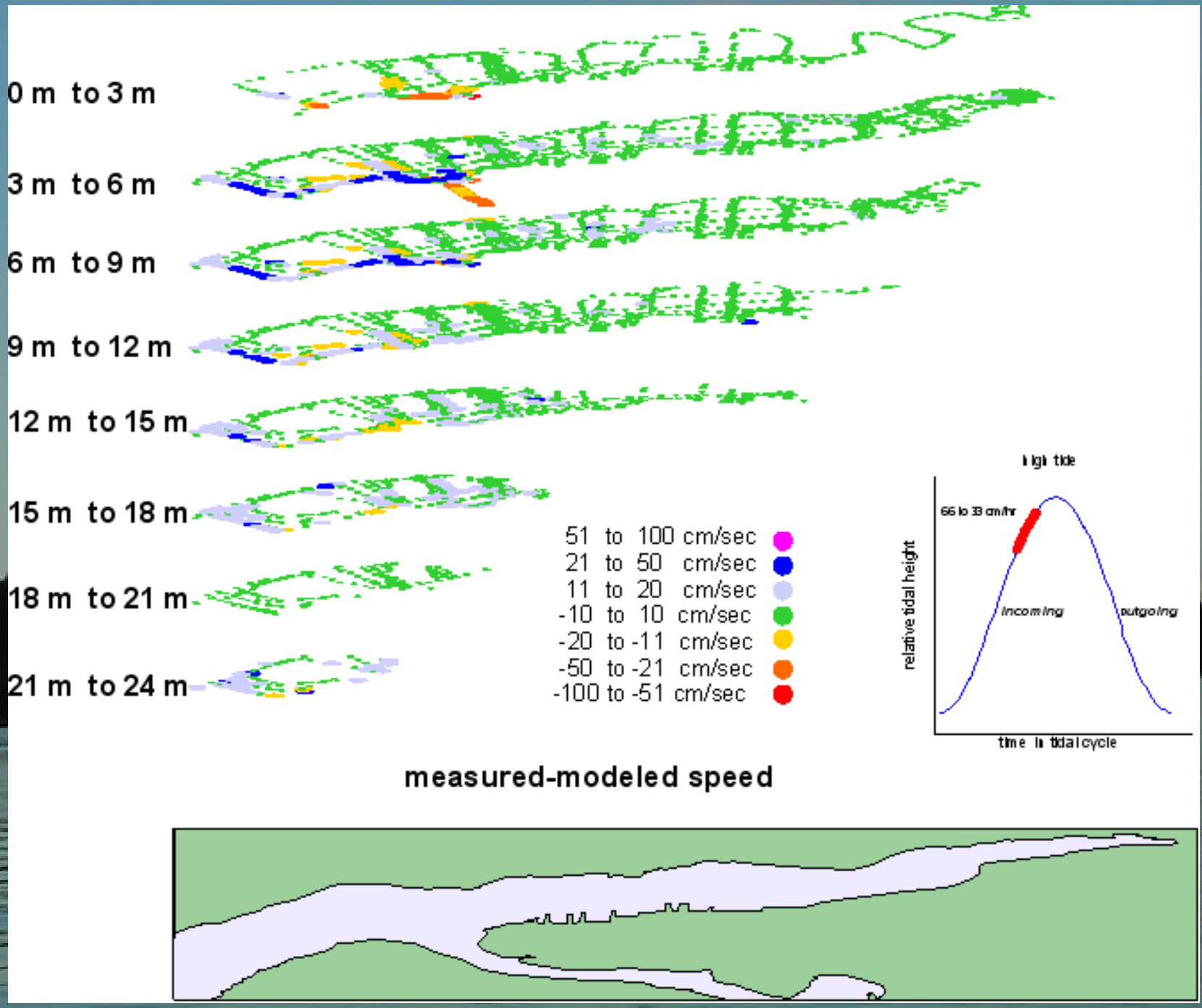
- Simulate FC Transport and Fate
  - Tide and Wind Driven Currents
  - Fecal Coliform Die Off
  - Freshwater Inflow
- Scenario Development
  - “Typical” CSO Events
  - Spills
  - TMDL Modeling

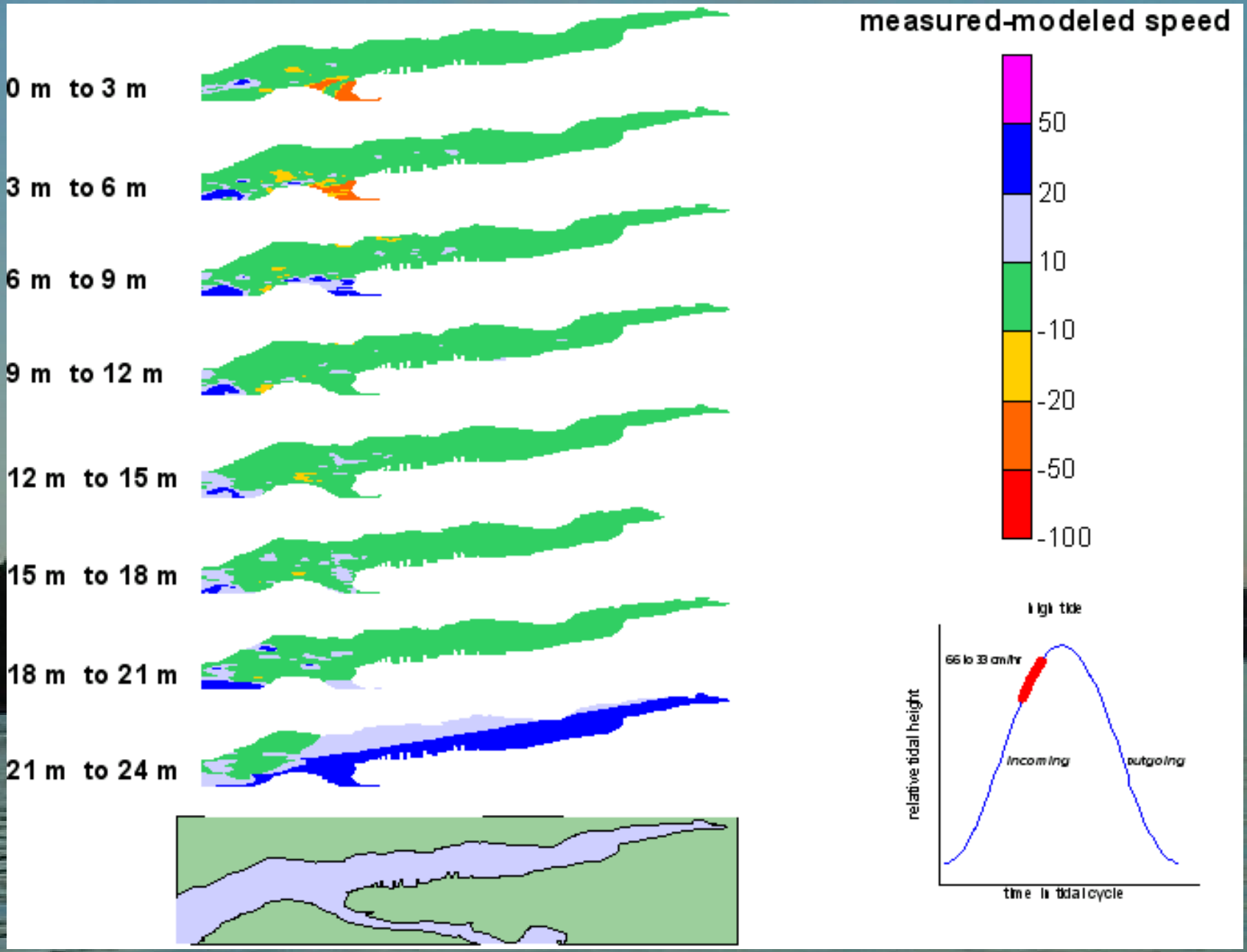
CH3D-FC Model



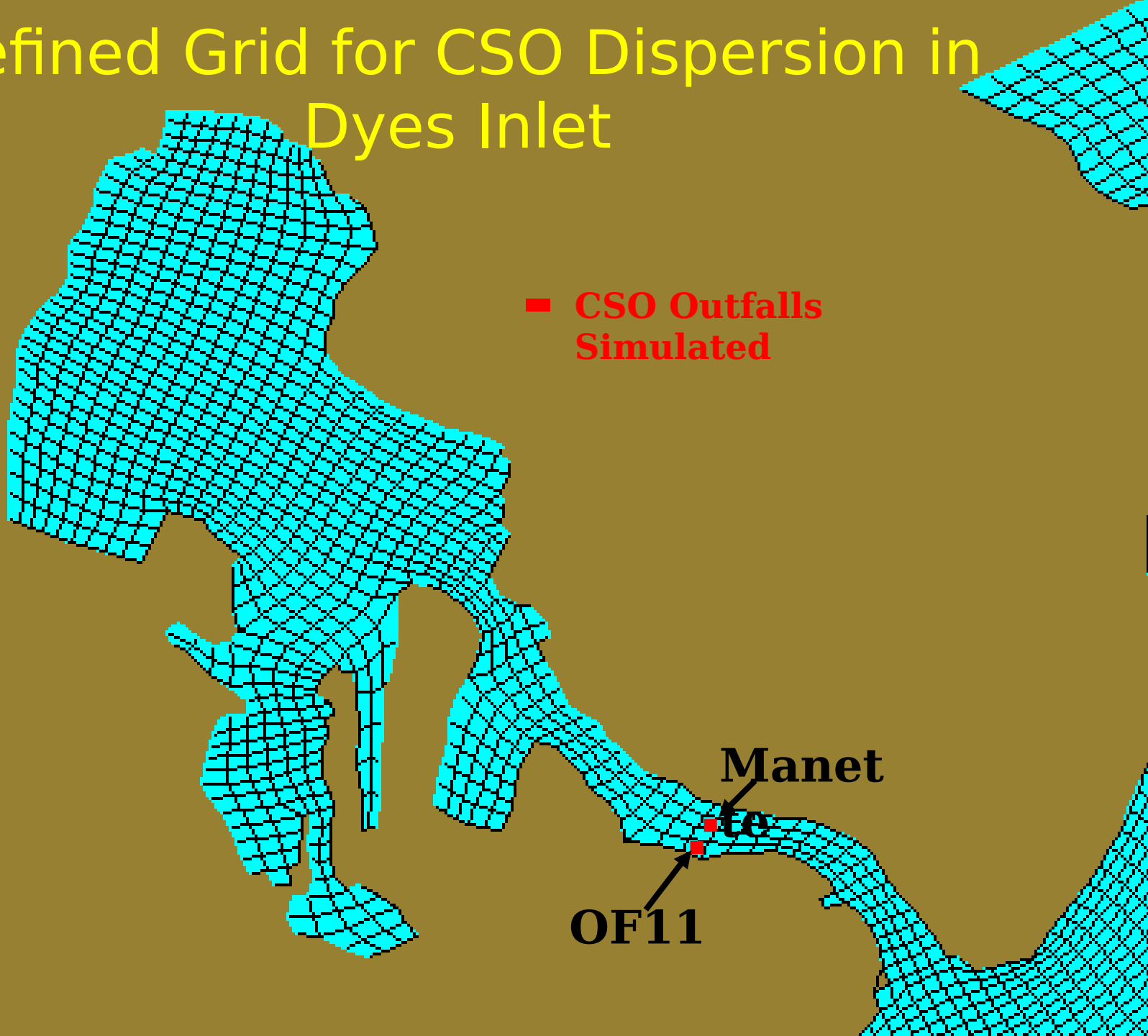



high tide
66 to 33 cm/hr
incoming
outgoing
relative tidal height
time in tidal cycle
measured-modeled speed
51 to 100 cm/sec
21 to 50 cm/sec
11 to 20 cm/sec
-10 to 10 cm/sec
-20 to -11 cm/sec
-50 to -21 cm/sec
-100 to -51 cm/sec


0 m to 3 m
3 m to 6 m
6 m to 9 m
9 m to 12 m
12 m to 15 m
15 m to 18 m
18 m to 21 m
21 m to 24 m
51 to 100 cm/sec
21 to 50 cm/sec
11 to 20 cm/sec
-10 to 10 cm/sec
-20 to -11 cm/sec
-50 to -21 cm/sec
-100 to -51 cm/sec
High tide
66 to 33 cm/hr
relative tidal height
incoming
outgoing
time in tidal cycle
measured-modeled speed


measured-modeled speed
50
20
10
-10
-20
-50
-100
0 m to 3 m
3 m to 6 m
6 m to 9 m
9 m to 12 m
12 m to 15 m
15 m to 18 m
18 m to 21 m
21 m to 24 m
High tide
66 to 33 cm/hr
incoming
outgoing
relative tidal height
time in tidal cycle

Refined Grid for CSO Dispersion in Dyes Inlet



Calculation of Threshold Flow Rates and Runoff Fraction for Storm Water

Storm water from rainfalls are difficult to estimate (measured or predicted).

We used CSO flows (measured Jan 6 and 7, 2002) with the measured 15-minute rainfall data to back-calculate the Threshold Value (TV) and Runoff Fraction (F) that are associated with the water treatment capacity.

The back-calculated TV and F were compared and evaluated against independent data and data behavior to validate their accuracy

Storm water flow was obtained from impervious surface in West. Bremerton

TV and F were used to predict surface

Calculation of Threshold Flow Rates and Runoff Fraction for Storm Water (Cont.)

Assumptions:

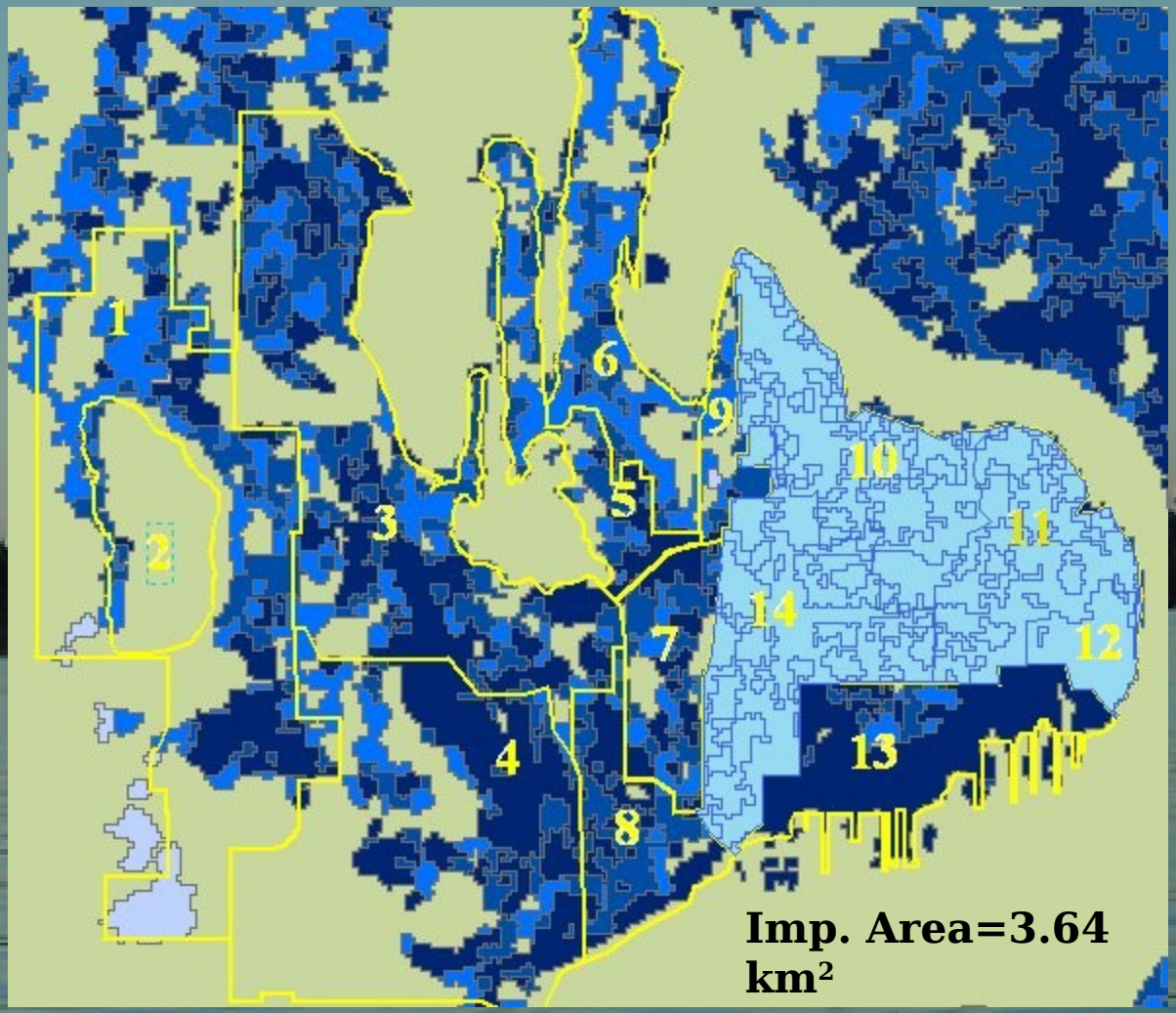
1) **CSO flow occurs when storm water inflow rate exceeds the threshold value (TV) of the treatment plant.**

2) **Total runoff to the treatment plant = treated water + CSO**

3) **Only a portion of the water over impervious surface goes to the treatment plant and this portion is the Runoff Fraction (F)**

4) **The CSO flows and rainfall data measured Jan 6 and 7, 2002 are accurate and consistent with each other.**

City of Bremerton Catch Basins Contributing to CSO



Calculation of Threshold Flow Volume and Runoff Fraction for Storm Water

CSO = (Rainfall x Impervious Area)*F – TV

Where F = Runoff Fraction calculated from empirical data

TV = Threshold Flow Volume of Treatment Capacity

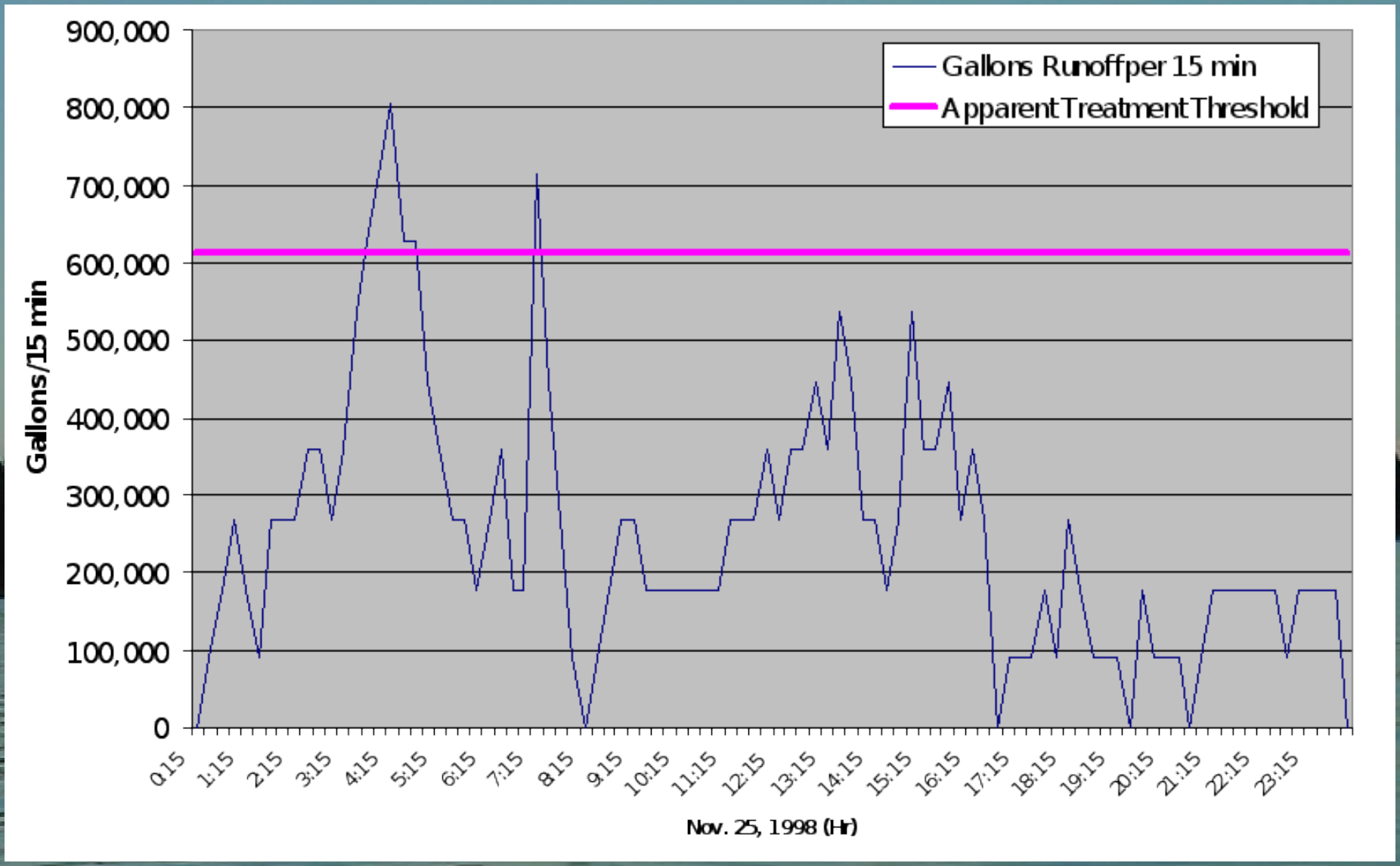
CSO was measured for both Jan 6 and Jan 7, 2002

Both F and TV can be solved from the following two equations:

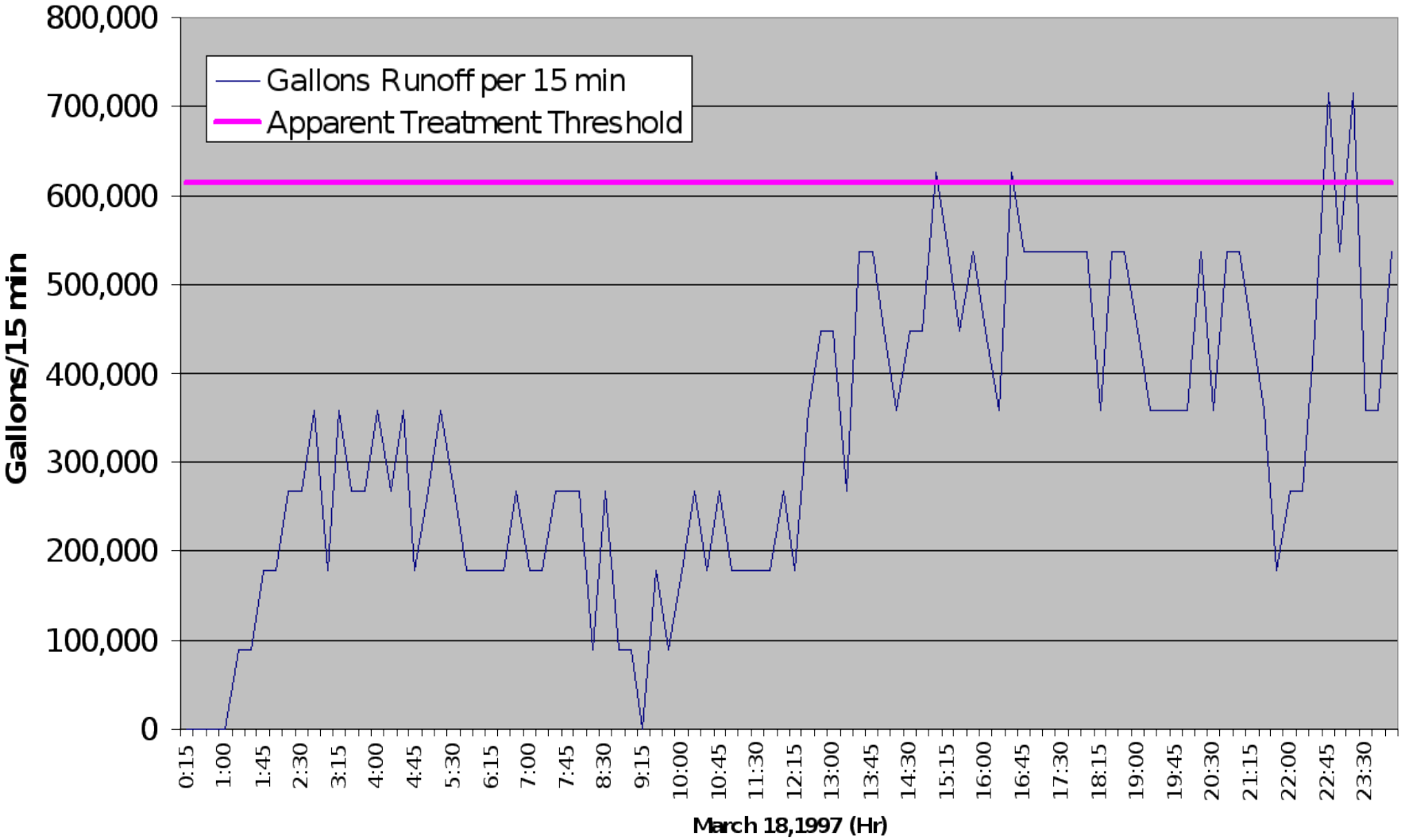
[1] Jan 6: 24,120 gal = (1.78 in x 3.64 km²)*F - TV

[2] Jan 7: 2,700,120 gal = (3.37 in x 3.64 km²)*F -

Nov 1998 Storm “2 year” Event (2.7 in/24 hr)



March 1997 “5 year” Event (3.48 in/24 hr)



Runoff Fraction

Inserting the calculated TV (613782 gal/15 min) into Eqs. (1) and (2), the Runoff Fraction was calculated:

F = 0.3667 for Jan 6, 2002

F = 0.3654 for Jan 7, 2002

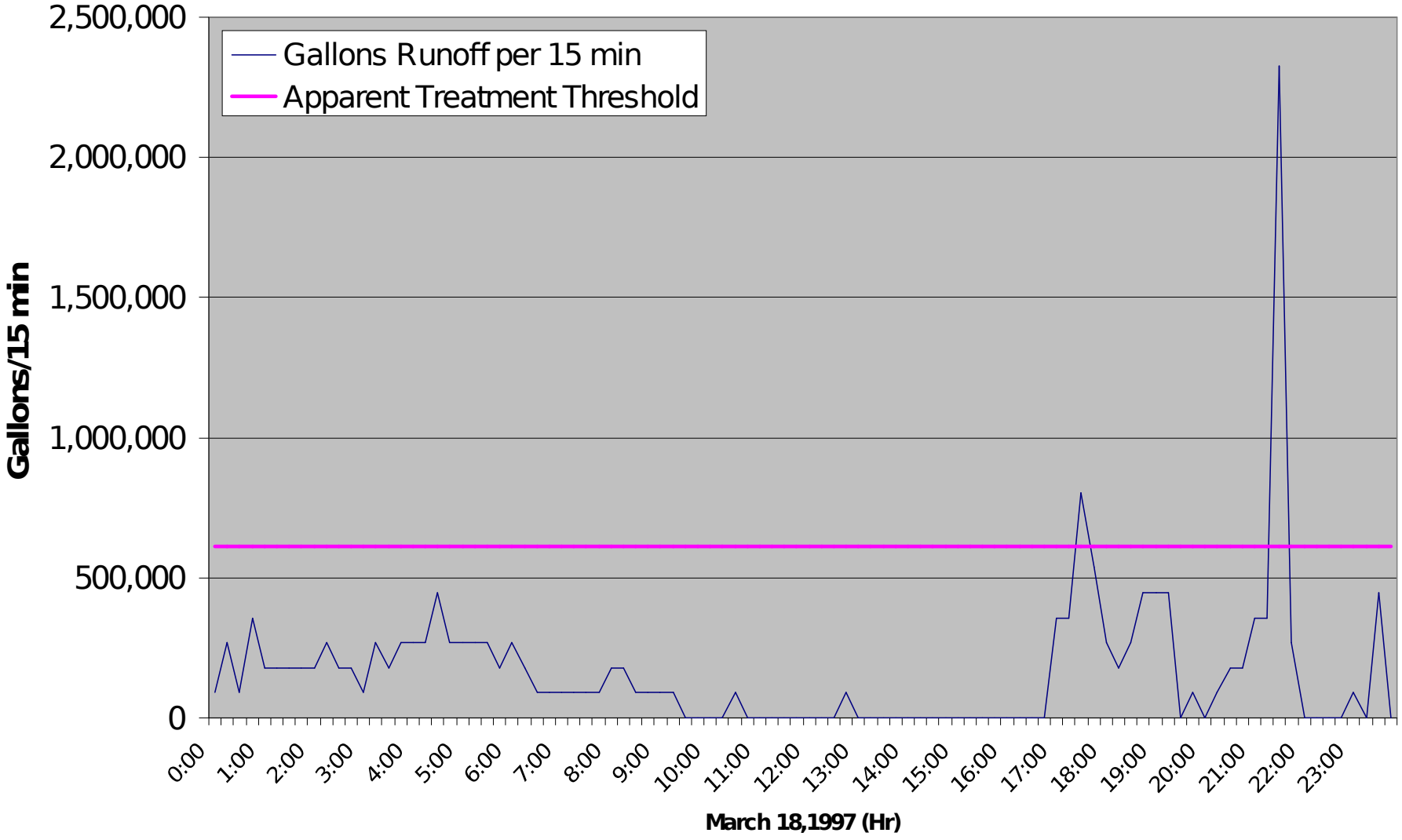
The average = 0.366 was used for our calculation for the CSO from the 11/28/98 and 3/17/97 storms

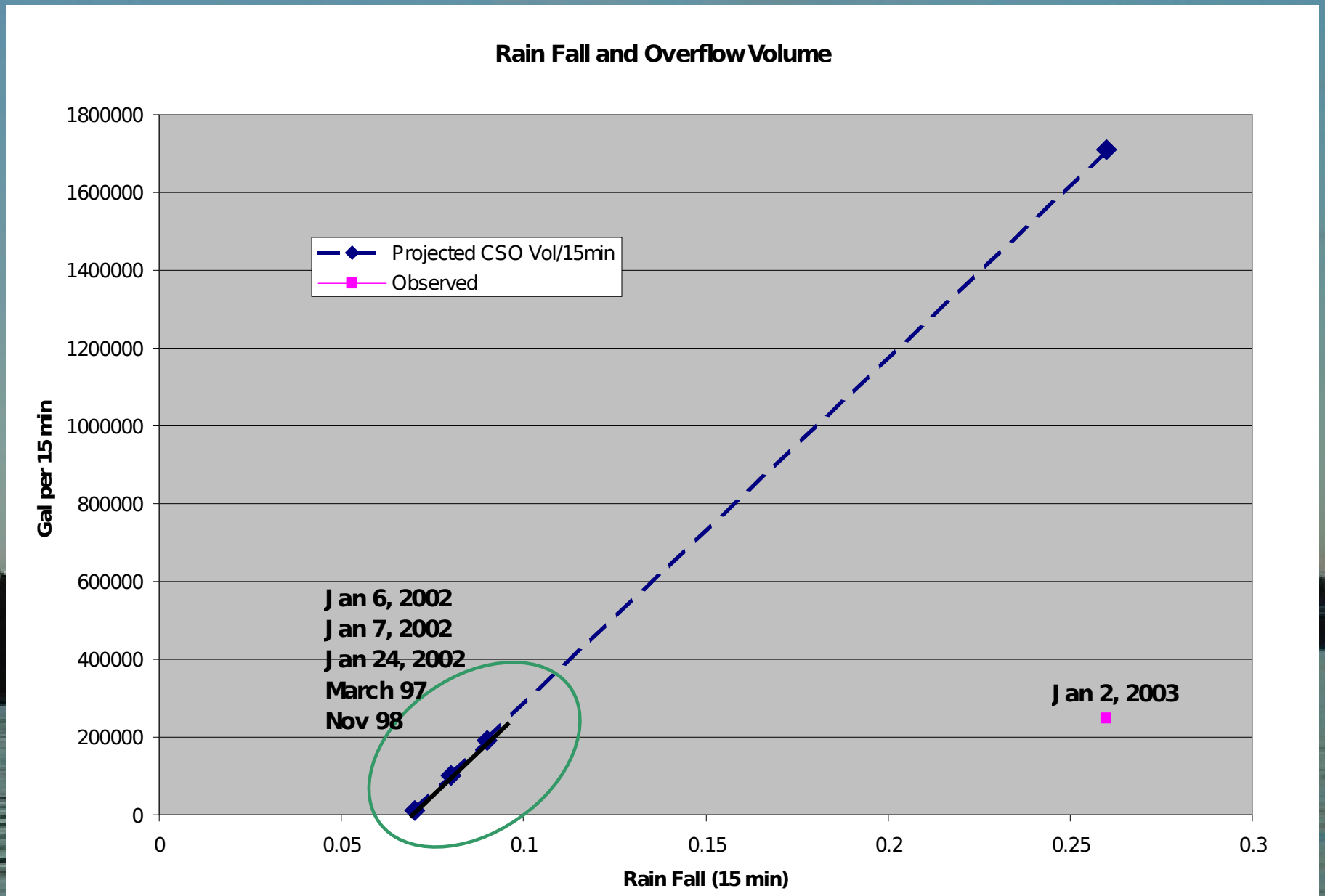
Projected CSO Flow Rate= F* (Vol above T.V.)	Current System 80% Capacity	Future System Full Design 100% Capacity
Nov 98 Storm	**429,900 Gallons/day**	**37,400 Gallons/day**
Mar 97 Storm	**227,000 Gallons/day**	**0 Gallons/day**

Validity and Accuracy of the Calculated F and TV

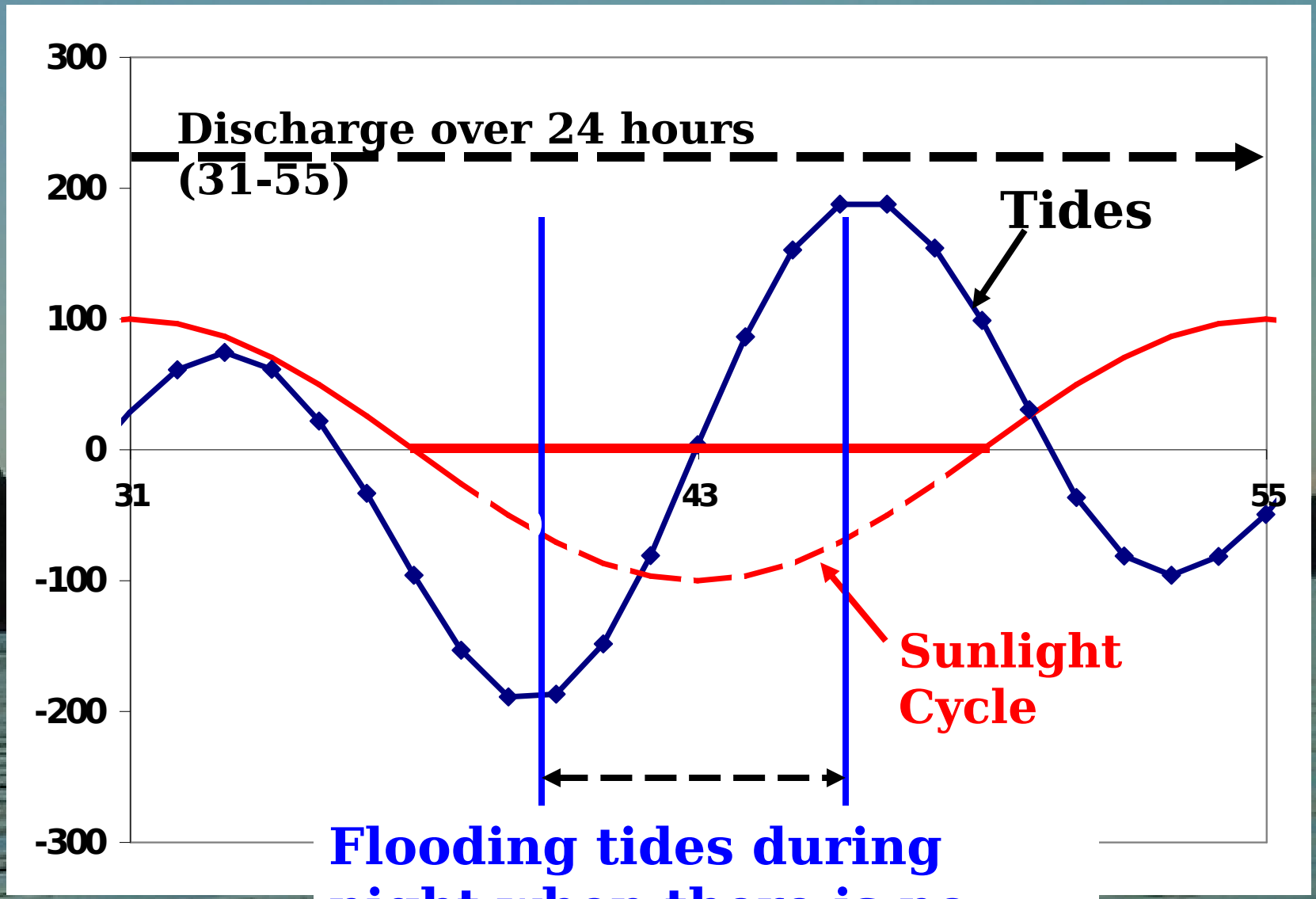
1) Calculations are based on measured CSO and rainfall data with the assumptions mentioned above
2) Calculated CSO ratio is a monotonic curve (~line) as the function of TV, meaning that there is only one TV appropriate for the CSOs behaving consistently between Jan 6 and 7, 2002.
3) Calculated Runoff Fraction are close to each other between Jan 6 and 7, implying that Runoff Fraction is independent of the storm intensity.
4) Calculated total storm water that goes to the treatment plant are ~24-32 MGD, much closer

Jan 2003 Storm




Rain Fall and Overflow Volume
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
Gal per 15 min
Projected CSO Vol/15min
Observed
Jan 6, 2002
Jan 7, 2002
Jan 24, 2002
March 97
Nov 98
Jan 2, 2003
0
0.05
0.1
0.15
0.2
0.25
0.3
Rain Fall (15 min)

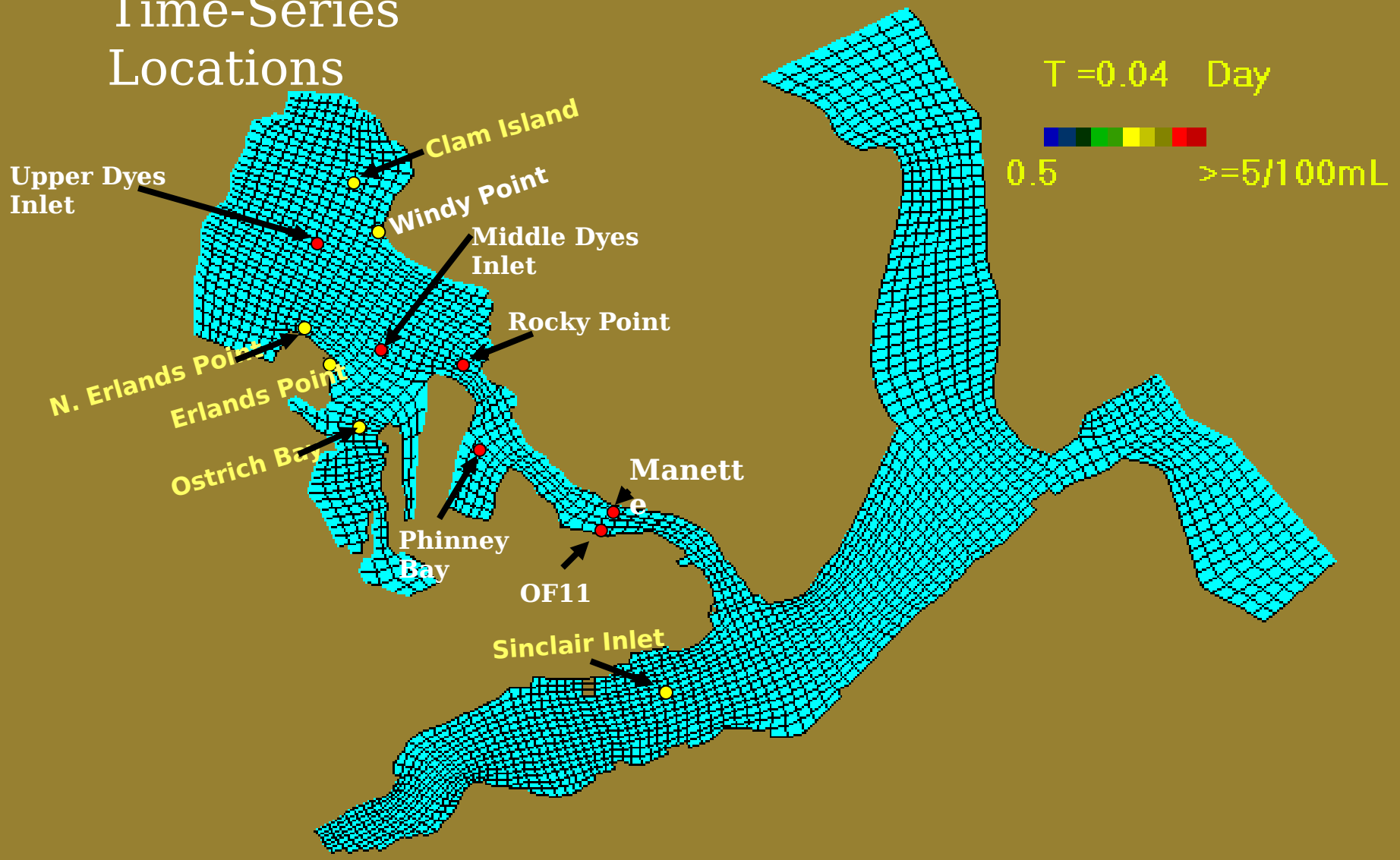
CSO Discharge Scenario



Sensitivity Analysis

- Wind – Constant wind 5 m/s (11.3 mph) from SW
- Turbidity – Decreased sechi depth by 50%
- Sunlight – Decreased sunlight intensity by 50%
- Fresh water inflow – Turn on annual mean flow from 10 major streams

Time-Series Locations



Locations for time series

Simulation Results

Link to Simulations Results Page

Summary

- CH3D-FC calibrated and verified for simulating FC transport (Mancini's Equ) in Sinclair and Dyes Inlets
- Empirical approach used to estimate "typical" CSO volumes
- Nov '98 and Mar '97 storms used to simulate overflow conditions
- Fecal coliform persistence controlled by dispersion and decay from sunlight
- FC concentrations predicted by model are based on conservative assumptions
- Simulation of July 2002 spill in Sinclair Inlet agreed with field data (2 samples)

Schedule

- Draft Report for Working Group Review (Aug 15 2003)
- Comments from Working Group (Sept 2003)
- Final Report (Dec 2003)